



nnual Report

2009



NOAA
National Climatic Data Center

MESSAGE FROM THE DIRECTOR



In 2009 climate service in NOAA was a topic of much study and planning.

Mary Glackin, Deputy Under Secretary for Oceans and Atmosphere, announced on February 2, 2009 that I had been appointed Director of all of NOAA's climate services. This was the start of a very busy year for me and for NCDC.

NOAA's climate services organizational framework is to focus on aligning and harmonizing internal climate efforts, understanding and responding to service demands, and improving understanding of climate change while establishing leadership positions for national and international engagement. Dr. Jane Lubchenco, confirmed in March as Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator, testified in May before the House Science and Technology Committee's Subcommittee on Energy and Environment on the concept of a national climate service, articulating its central importance and describing NOAA's interest and capacity to help develop and implement it. In February 2010, Department of Commerce Secretary Locke announced the intent to reprogram and create a NOAA Climate Service (NCS). I am presently serving as the Transition Director and continuing to serve as NCDC Director. NCDC will clearly be a cornerstone of the NOAA Climate Service.

NCDC had a defining role in two efforts, key to the NCS, completed in 2009: NOAA Climate Services Portal and the United States Global Change Research Program's report "Global Climate Change Impacts in the United States". I would also like to acknowledge NCDC's scientific excellence in developing and providing data and products that are the basis for climate monitoring and assessments, the mainstays in understanding climate change and climate variability. The science must underpin the NCS.

Throughout the year, employees have stepped up to do "more than" their regular duties in the context of an emerging NCS. I want to take this opportunity to thank the

NCDC employees and contractors for their dedication and patience as we plan for and undergo changes to expand and improve climate services across NOAA. Change is difficult for some, but this is a unique opportunity for NCDC. NCDC continues to provide extraordinary customer service and support services are expanding and improving to meet the growing needs.

Although I wear two hats, NCDC is my home team, and it has grown this year. On July 1, 2009 the North Carolina extension of the Cooperative Institute for Climate and Satellites (CICS-NC), with an engagement site at NCDC, was established. The five year competitive award, with North Carolina State University as NCDC's academic partner, includes a consortium of universities and other organizations. The academic partnership with research organizations will be beneficial in expanding and improving climate services.

The following report presents the many accomplishments at NCDC in 2009. Each of you should be proud of your contribution to NCDC, NOAA, and the Nation. I am extremely proud of NCDC, its mission, and the dedication of the employees and contractors. Keep up the good work. If the NCS plan is successful, the next annual report will find NCDC in a new line office with even greater opportunities to serve.

A handwritten signature in black ink that reads "Thomas R. Karl". The signature is fluid and cursive.

Thomas R. Karl, L.H.D.,
Director

The climate is changing
in multiple ways.



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HIGHLIGHTS OF 2009

New NOAA Administrator Visit to NCDC

Dr. Jane Lubchenco, the Undersecretary of Commerce for Oceans and Atmosphere and the ninth administrator for NOAA, visited NCDC on August 12, 2009. During her visit, she toured NCDC and the local U.S. Climate Reference Network site, met with representatives of the newly formed Cooperative Institute for Climate and Satellites, and talked



Dr. Jane Lubchenco
Under Secretary of Commerce
for Oceans and Atmosphere
and NOAA Administrator.

with local dignitaries at a reception hosted at the North Carolina Arboretum. Among the highlights of the NCDC tour was an overview of NCDC's climate services activities, focused on user engagement across a dozen sectors; portal development efforts for climate and drought information and model data; and regional activities contributing to a better understanding of global climate change impacts. As part of her visit, Dr. Lubchenco held a local

town hall event where she emphasized NOAA's commitment to the discovery, sharing, and utilization of scientific knowledge related to the earth sciences.

New NOAA-Supported Cooperative Institute for Climate and Satellites

NCDC has a major new partner in the new Cooperative Institute for Climate and Satellites (CICS), which was established in July 2009. The cooperative institute represents a consortium of academic, non-profit, for-profit, and community organizations, and is co-led through a partnership between North Carolina State University on behalf of the University of North Carolina System (CICS-NC) and the University of Maryland College Park (CICS-MD). CICS-NC is co-located with NCDC. Other consortium members include the University of California-Irvine, Colorado State University, Howard University, the University of Miami, Duke University, the University of North Carolina-Chapel Hill, Princeton University, City University of New York, Columbia University, Oregon State University, and Remote Sensing Systems in Santa Rosa, California.

CICS provides foci for collaborative research and associated activities in support of NOAA mission goals related to satellite and climate data and information research and development. CICS conducts collaborative research with NOAA scientists in three principal thematic areas:

- Climate and Satellite Research and Applications,
- Climate and Satellite Observations and Monitoring
- Climate Research and Modeling.

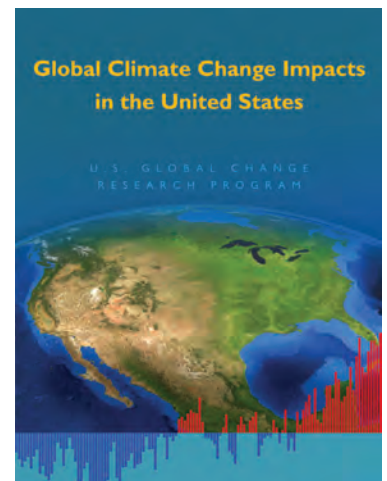
The cooperative institute will use satellite observations to detect, monitor, and forecast climate change and its impact on the environment, including ecosystems. In addition to studying data from satellites currently in operation, scientists will also extract climate data from two next-generation satellite systems: the Geostationary Operational Environmental Satellite-R (GOES-R) series and the National Polar-orbiting Operational Environmental Satellite System (NPOESS).

The disciplinary and geographically broad CICS consortium constitutes a first step toward the implementation of a national academic infrastructure needed to support a NOAA Climate Service. In total, NOAA supports 23 cooperative institutes across the United States to promote research, education, training, and outreach aligned with NOAA's mission. Cooperative institutes collaborate with NOAA scientists, coordinate resources among all non-government partners, and promote the involvement of students and post-doctoral scientists in NOAA-funded research. To learn more about CICS, please visit: www.cicsnc.org.

Global Climate Change Impacts in the United States Release

NCDC scientists played a central role in developing *Global Climate Change Impacts in the United States*, which is an authoritative assessment of the most up-to-date climate change science available. The report, which underwent extensive public and peer review, outlines climate-related trends and projections for the nation as well as for specific regions and sectors of the United States.

The report summarizes the science and the impacts of climate change on the United States,



Global Climate Change Impacts in the United States, an authoritative assessment of the most up-to-date climate change science available.

now and in the future. It focuses on climate change impacts in different regions of the United States and on various aspects of society and the economy such as energy, water, agriculture, and health. It is also a report written in plain language with the goal of better informing public and private decision making at all levels.

Some key findings include:

Climate changes are underway in the United States and are projected to grow.

Climate-related changes are already observed in the United States and its coastal waters. These include increases in heavy downpours, rising temperature and sea level, rapidly retreating glaciers, thawing permafrost, lengthening growing seasons, lengthening ice-free seasons in the ocean and on lakes and rivers, earlier snowmelt, and alterations in river flows. These changes are projected to grow.

Crop and livestock production will be increasingly challenged.

Agriculture is considered one of the sectors most adaptable to changes in climate. However, increased heat, pests, water stress, diseases, and weather extremes will pose adaptation challenges for crop and livestock production.

Threats to human health will increase.

Health impacts of climate change are related to heat stress, waterborne diseases, poor air quality, extreme weather events, and diseases transmitted by insects and rodents. Robust public health infrastructure can reduce the potential for negative impacts.

The NCDC Graphics Team was an essential part of the report's production, working closely with the author team to edit the report, create essential maps and visual aids, and design the layout for the finalized document. To access the report online, please visit: www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/full-report.

Annual State of the Climate Report for 2008

Monitoring and reporting on the state of the Earth's climate is one of NCDC's most visible activities in support of NOAA's mission to understand changes in the Earth's environment. NCDC's monthly, seasonal, and annual state of the climate reports are widely disseminated and referenced by scientists, international organizations, and the media, among others. In 2009, NCDC published the *State of the Climate in 2008* annual report as part of the August 2009 issue of the *Bulletin of the American Meteorological Society*. The annual state of the climate report documents significant climate events that occurred during the year and provides

summaries of global and regional climate conditions as well as placing those conditions into historical context.

The scope of this report has increased substantially in recent years. The report on 2008 contained contributions from more than 280 authors, representing every continent and from numerous different research groups, to collaborate, share data and insights, and describe the observed changes in climate from different perspectives. The 2008 report gained an even wider international perspective with the addition of chapter editors from the UK Met Office, Environment Canada, and Australia's National Climate Centre, as well as an expanding list of international authors. The report is available online at: www.ncdc.noaa.gov/oa/climate/research/2008/ann/bams/full-report.pdf.

DATA MANAGEMENT AND STEWARDSHIP

New "What to Archive" Process Adopted

A new process for submitting data for archival was established in 2009 by NCDC in support of NOAA's Procedures for Scientific Records Appraisal and Archive Approval. This process includes compilation of essential metadata, notification of appropriate NCDC personnel and completion of a Submission Agreement, and it ensures essential resources are available for supporting the data through its life cycle. The first application of this process was for the Climate Database Modernization Program (CDMP) U.K. East India Company (UKEIC) Marine Logbooks data submission. The UKEIC marine logbook data are digital images of instrumental measurements and weather observations made aboard East India Company merchant ships from 1786 to 1834. The total submission will include 1,100 logbooks with an estimated total volume of 475 gigabytes.

Climate Database Modernization Program: A Decade of Achievement

The Climate Database Modernization Program (CDMP) supports NOAA's mission to collect, integrate, assimilate, and effectively manage Earth observations on a global scale, ranging from atmospheric, weather, and climate observations to oceanic, coastal, and marine life observations. Many of these holdings, which are part of the U.S. National Archives, were originally recorded on paper, film, and other fragile media, and stored at various NOAA Centers. CDMP has greatly improved the preservation and access to NOAA's holdings by migrating many of these resources

to new digital media. Partnering with four private sector contractors, CDMP has placed over 53 million weather and environmental images online, available to researchers around the world via the Internet. The amount of data online has grown from 1.75 terabytes in 2001 to over 11 terabytes in 2009. Major progress continues in making these data available through a number of NOAA websites. The increase in the quality and quantity of historical data is helping researchers worldwide to improve real-time monitoring and forecasting of environmental, solar, and geophysical events. For further information about the CDMP, please visit: www.ncdc.noaa.gov/cdmp.html.

Mexican Data Rescue

The CDMP at NCDC is leading a multi-year effort to key nearly five million temperature and precipitation observations for 34 key Mexican observatories for the period 1879 to 1972. In collaboration with NOAA's NWS and the Mexican Meteorological Service, approximately one-third of the keyed data became available in summer 2009. The data rescue effort will be completed by 2012, markedly expanding NOAA climate databases, which will greatly enhance the quality of various research studies and climate perspectives on North American drought.

NOAA's National Operational Model Archive and Distribution System

NOAA's National Operational Model Archive and Distribution System (NOMADS), a distributed Web services-based project, expanded its holdings for standards-based access to climate, reanalysis, and numerical weather prediction model datasets at NCDC in 2009. At the recommendation of the Science Advisory Board, NOMADS advanced its access services by scaling its web services and archive access to accommodate the next suite of reanalysis datasets from NOAA's Explaining Climate to Improve Predictions project. NOMADS developed methods for advanced temporal, spatial, and model variable access to these massive datasets, all in a format neutral manner. Before the expected 2010 release of the 250 terabyte dataset from National Centers for Environmental Prediction's Coupled Climate Forecast System Reanalysis, NOMADS developed and tested a prototype access capability. NOMADS

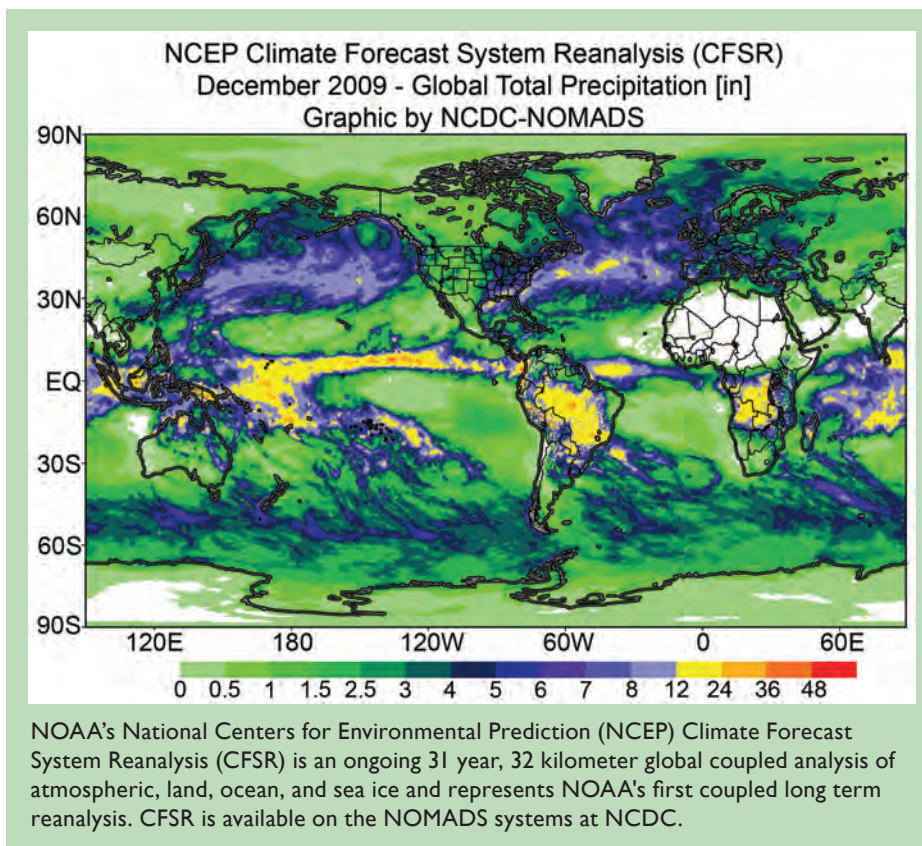
also developed a bulk order capability that permits faster and easier user access to the archive by caching previous requests to disk therefore reducing user access wait time.

Other organizations increased their use of NOMADS in 2009: the NWS expanded its use of NOMADS adopted standards to Dallas TX, Boulder CO, and Silver Spring MD, and the National Ocean Data Center's National Coastal Data Distribution Center developed and implemented its "Ocean-NOMADS," now providing user access to NOAA and Navy ocean models.

NOMADS users are permitted easier access to various models and reanalysis datasets, ranging from the real-time to historical, using the same data access standards and protocols. NOMADS continues to be recognized as a pathfinder project in the world of interoperable access to data. For more information, please visit: nomads.ncdc.noaa.gov.

Comprehensive Large Array-Data Stewardship System

The environmental stewardship mission of NESDIS is to acquire, archive, and disseminate environmental data from a variety of *in situ* and remote sensing observing systems throughout NOAA and from a number of NOAA's partners. The Comprehensive Large Array-Data Stewardship System



(CLASS) is under development to serve as the archive information technology infrastructure for that data. It is also operational while development continues.

During 2009 the CLASS Operations and Planning Board, which is coordinating the transition from development to operations, decided that model output would be stored in CLASS. This capability will support future needs of NOAA to provide climate services.

At the end of 2009, the volume of data encompassed by CLASS operations exceeded 1.1 petabytes, having grown by 27 percent during the year. The CLASS IT data storage infrastructure includes a mix of storage area network (SAN) disk arrays and tape robotics systems. The data storage systems at NCDC include a 384 terabyte-capacity SAN and a tape robotics library with slots for 10,000 tape cartridges. Storage capacity of the tape library is four petabytes with tape, and will grow to eight petabytes with the next generation tape cartridge. Trends in CLASS-based storage in the archives will be significantly increased by the inclusion of data streams from new satellite missions, climate model output, and radar data. For more information, please visit: www.class.ngdc.noaa.gov/saa/products/welcome.

Acceleration of NCDC's Climate Data Record Program

NCDC received significant funding through the American Recovery and Reinvestment Act (ARRA) of 2009, commonly known as the Stimulus Program, as well as NOAA's Climate Program Office, to accelerate development of its satellite Climate Data Record Program (CDRP). Following the principles outlined by the U.S. National Research Council and other organizations, the CDRP is designed to unleash the potential of past, present, and future satellite data to address critical climate change and variability questions and allow societal sectors (e.g., agriculture, health, defense, energy) and regional stakeholders to make well-informed strategic decisions.

The CDRP is designed to produce two important types of data records:

Climate Data Records, which are created from the initial data collected by satellites. Examples include atmospheric and sea surface temperatures, snow and ice conditions, and atmospheric greenhouse gas concentrations. CDRs reveal Earth's short and longer-term environmental changes and variations allowing scientists to better understand the climate system; assess the state of the climate on regional, national, and global scales; and project future climate states.

Climate Information Records, which are created from CDRs and provide specific information about environmental phenomena of particular importance to science and society. Examples include hurricane trends, Arctic sea-ice coverage, and drought patterns. This information allows businesses, resource managers, decision makers, and the public to better understand and adapt to climate changes and variability, develop strategies to minimize risks, and mitigate possible impacts on society.

In 2009, the CDRP conducted its first major grants competition for the development of climate data records and processing capabilities. Forty-five proposals from academia, industry and the federal government were reviewed and scored by an expert panel. Seven proposals, totaling more than \$2M, were funded. The CDRP continued to support additional competed proposals, totaling more the \$1M, from prior year competitions. The CDRP also awarded a competed contract for integration support. For additional information on CDRP, please visit: www.ncdc.noaa.gov/sds/index.html.

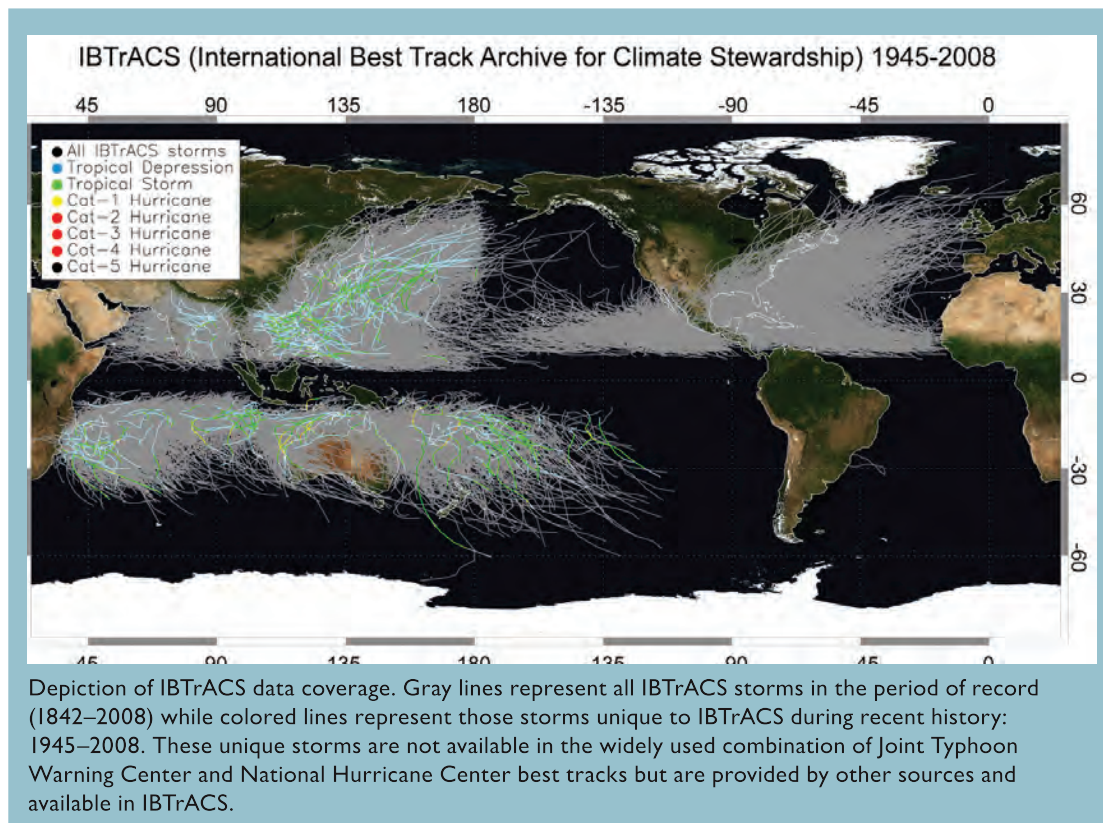
Renewable Energy and Climate Data Records

In 2009, NCDC produced SeaWinds, a global, high resolution sea surface wind product, using over 20 years of remotely sensed data from multiple satellite-based instruments. SeaWinds provides highly useful information worldwide for both the public and research sectors. For example, SeaWinds provides wind climatologies for the Offshore Wind Energy community, it is used by NOAA Coral Reef Watch to predict coral bleaching events, and it provides wind stress estimates for the ocean and climate modeling communities to aid in the production of coastal upwelling estimates.

In November 2009, NCDC along with representatives from the Department of Energy's National Renewable Energy Laboratory, the NASA Langley Research Center, and private industry kicked off a joint effort to use advanced solar resource mapping techniques to support the expanded use and efficient operation of distributed solar energy technologies. NCDC will provide fundamental climate data records from global geostationary satellite data that will be used to compute solar energy resource statistics at high resolution globally and help to plan efficient use of solar power.

International Best Track Archive for Climate Stewardship

The announcement of the availability of the International Best Track Archive for Climate Stewardship (IBTrACS)



was published in an article in *Eos, Transactions of the AGU* in February 2009. Concurrent with the *Eos* publication, the IBTrACS geospatial services were made public on NCDC's website. NCDC released version 2 of the IBTrACS global tropical cyclone dataset in July 2009.

Tropical cyclone best track data are used to monitor the positions and intensities of tropical cyclones using data from numerous sources, and the IBTrACS project consolidates all best track data globally into one location. Best track data include the position, maximum sustained wind, and minimum central pressure of a tropical cyclone at six-hour intervals. The IBTrACS dataset is the world's largest repository of global best track data and is provided in numerous formats to support the diverse communities interested in tropical cyclones. Thus, IBTrACS facilitates an improved understanding of the distribution, frequency, and intensity of tropical cyclones globally. IBTrACS is now an internationally recognized source of global best track data and is available online via the World Data Center for Meteorology-Asheville at www.ncdc.noaa.gov/oa/ibtracs.

Hurricane Satellite Data Translation into Google Earth

NCDC successfully translated the 1.4 million images that comprise the Hurricane Satellite (HURSAT) dataset for over 3,300 global tropical cyclones from 1978 to 2008 into a user-friendly Google Earth format. Visible, infrared, and microwave satellite imagery from geostationary and polar

orbiting satellites are organized based on the storm tracks from the IBTrACS dataset. Users may browse the archive of tropical cyclones and choose from a variety of display methods to aid in their analyses.

CLIMATE SERVICES

NOAA Virtual Data Systems

The NOAA Virtual Data System is comprised of Climate Data Online Services (for example, Quality Controlled Local Climatological Data), Geographic Information System (GIS) Services, an Image and Publications System, and Next Generation Radar (NEXRAD) Data Services, among other areas.

NCDC delivered 674 terabytes of data online during 2009—roughly double that of the previous year—with over 550 million hits/downloads from NCDC's website during that time. This continues the rapid growth seen over the past ten years in data access via NCDC's Web resources and also reflects enhancements made during 2009 to allow customers to download much larger volumes of data. Over 2 petabytes of data are now accessible from NCDC's website, including *in situ*, NEXRAD, satellite, and model data. NCDC continues to implement hardware upgrades to handle the rapidly increasing system load and to manage this growing online resource.

U.S. Drought Portal

In early 2009, a new look and feel was applied to the U.S. Drought Portal (USDP) along with an improved navigation scheme. In addition, region-specific information was portrayed through the use of communities (defined groups of users) for National Integrated Drought Information System (NIDIS) pilot projects and visualization and interpretation of data and information were improved.

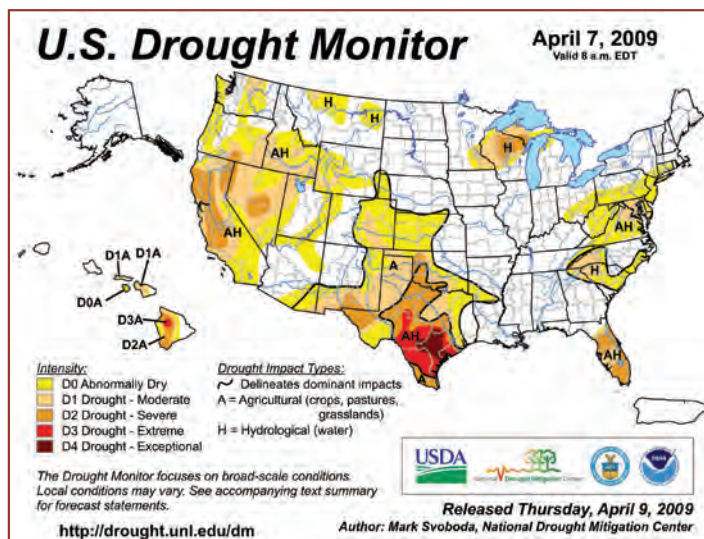
The USDP established communities for the Upper Colorado River Basin and Southeast U.S. NIDIS Pilot Projects. These communities are available to those participating in the pilot projects and are designed to facilitate discussion and idea sharing as well as to provide a central clearinghouse for tools used by local decision makers in the pilot area. These communities also keep track of tasks, provide document handling, and allow sharing of information within the pilot group that a particular contributor does not wish to distribute to the entire Internet. At the same time, these communities are contributing to an effort to improve drought depiction and early warning in the pilot area. Once the pilot project is sufficiently mature, a public instance for the area or region will be developed and implemented providing a more detailed local look at drought than is currently available via the USDP.

The USDP partnered with UNC Asheville to improve mapping service in the Portal and to integrate mapping and graphing components into a single application capable of rendering information from nearly all of NCDC's databases. These applications will continue to be tested and improved in the pilot communities in FY2010 before being released to the general public. These visualizations have been incorporated into the NOAA Climate Services Portal.

The USDP can be accessed at www.drought.gov.

Ten Year Anniversary of Weekly U.S. Drought Monitor Releases

Since its first release on May 20, 1999, the U.S. Drought Monitor (USDM) has brought attention to the nation's drought issues by providing an at-a-glance depiction of drought location and severity for the United States. The USDM has been heralded as a model for interagency cooperation and public-private partnership with author duties rotating between NCDC and the NWS; the U.S. Department of Agriculture's Office of the Chief Economist; the National Drought Mitigation Center at the University of Nebraska, Lincoln; and the Western Regional Climate Center at the University of Nevada, Reno. The USDM combines measures of drought conditions into a single



The 500th installment of the U.S. Drought Monitor was released on April 7, 2009.

composite indicator that characterizes drought intensity on a scale similar to tornadoes and hurricanes (for example, a one-in-fifty-year drought being considerably more serious than a one-in-ten-year drought) and incorporates input from federal, state, and academic reviewers for each week's map, leveraging an expert community that has grown from 17 to 270 over a decade. On April 7, 2009, NCDC contributed to the 500th installment of the weekly USDM. All USDM maps, forecasts, and related information can be found at: www.drought.unl.edu/dm/.

NOAA Climate Services Portal Development

With the rapid rise in the development of Web technologies and climate services across NOAA, there has been an increasing need for greater collaboration regarding NOAA's online climate services. The drivers include the need to enhance NOAA's Web presence in response to customer requirements, emerging needs for improved decision-making capabilities across all sectors of society facing impacts from climate variability and change, and the importance of leveraging climate data and services to support research and public education.

To address these needs, during FY2009 NOAA embarked upon an ambitious program to develop a NOAA Climate Services (NCS) Portal. Four NOAA offices are leading the effort: the NOAA Climate Program Office, the National Ocean Service's Coastal Services Center, and the NWS's Climate Prediction Center, along with NCDC. Other offices and programs are also contributing in many ways to the effort. The NCS Portal completed a successful "soft rollout" on December 2, 2009, in time for the Climate Conference in Copenhagen, Denmark, which began on December 7, 2009.

The prototype NCS Portal was placed online at www.climate.gov for public access in January 2010.

Portal-Based Pacific Climate Information System: A Regional Demonstration

In 2009, NOAA's Integrated Data and Environmental Applications (IDEA) Center developed a demonstration prototype access page for placement on the NCS Portal. This Pacific Climate Information System (PaCIS) component of the portal allows users to readily access regionally-focused climate information for the Pacific region. The PaCIS site offers a demonstration of regional information on the NCS Portal that meets specific requirements related to supporting PaCIS as the prototype regional climate service. As regional climate services are established by NOAA across the United States, the PaCIS site will serve as a development model, including content and background hosting elements such as metadata repositories, portlet content, and data streams that are powered by a geoportal database and other content management systems.

In July 2009, NCDC and PaCIS participated in the inaugural meeting of the Pacific Adaptation to Climate Change (PACC) in Apia, Samoa. PACC was the first region-wide adaptation project in the Pacific to help 13 countries address the adverse affects of climate change with project funding for FY2010. The funding will help start adaptation projects for three major climate change concerns: food security, water resources, and coastal management. PaCIS will play a critical role in collaboration on water resources issues and in collecting and developing content that will be disseminated via the PaCIS Portal.

Geographic Information Services

In 2009, NCDC made great progress toward the goal in developing and deploying Geographic Information System (GIS) services at NCDC to provide users with simple access to data archives while integrating new and informative climate products. This is achieved by providing a variety of climatic data in GIS formats, map views, and visualizations. Online GIS Map Services provide data discovery options to users which include multi-layer settings, region and zip-code search tools, gazetteer (geographical dictionary search) functions, help tools, and supporting dataset information. Map services for *in situ* data include global climate/weather data for tens of thousands of locations, severe weather data, and a variety of climatological products and summaries.

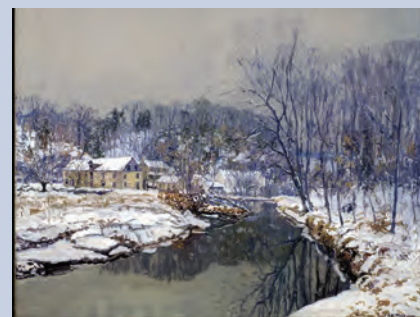
NCDC's GIS related products provide Open Geospatial Consortium compliant Web Map Services, Web Feature Services, and Federal Geographic Data Committee metadata as a complement to the map viewers. User friendly Google Earth formats also provide access. For more information on NCDC's GIS resources, please visit gis.ncdc.noaa.gov/geoportal.

ArcGIS Server Geoportal Extension

The ArcGIS Server Geoportal Extension to manage data interoperability was implemented in 2009. This tool is used to support data access through Climate Data Online, the National Climate Service Portal, and the U.S. Drought Portal. In 2009, a daily snowfall mapping application was placed online at gis.ncdc.noaa.gov/maps/dailysnowfall. map. This application presents daily snowfall for the last six months and has the ability to accumulate snowfall up to a two-week period.

NOAA's NCDC Determines Most Likely Date of the Painting of "The Mill in Winter"

NCDC was contacted by a researcher at the Corcoran Gallery of Art in Washington, D.C., to see if meteorological data could be used to determine the date and history of the creation of a painting in their collection. Edward Willis Redfield, the Pennsylvania impressionist artist, painted "The Mill in Winter" outdoors near Center Bridge, Pennsylvania, during the snow in a single day. The Gallery knew the painting was initially displayed on November 17, 1922, but it was not known if it had been painted earlier in the winter season of 1922-1923, or during the previous winter. Based on four active cooperative weather stations recording excellent observations during that time and a copy of the painting itself that showed leaves remaining on trees, snow clinging to the tree limbs, and a slow flowing river with no ice, it was deduced that the date of the painting of Redfield's "The Mill in Winter" is most likely to have been December 4, 1921.



Artist: Edward Willis Redfield; Title: *The Mill in Winter*; Date: c. 1922; Medium: Oil on canvas; Dimensions: 50.25 x 56.5 inches; Accession Number: 23.11; Courtesy of: Corcoran Gallery of Art, Washington, DC; Credit Line: Museum Purchase, Gallery Fund

Severe Weather Data Inventory

In 2009, the Severe Weather Data Inventory (SWDI) became operational and publicly available. SWDI at NCDC provides user access to several datasets critical to the detection and evaluation of severe weather. These datasets include Next Generation Radar (NEXRAD) Level-III point features describing general storm structure, hail, mesocyclone, and tornado signatures; NWS Storm Events Database; NWS Local Storm Reports collected from storm spotters, NWS Warnings; and lightning strikes from Vaisala's National Lightning Detection Network. Data access is available from the NCDC website, URL-based (REST) Web Services, and FTP. The data may be saved in a variety of formats. For more information, please visit www.ncdc.noaa.gov/swdi.

Weather and Climate Toolkit

NCDC's Weather and Climate Toolkit is an application that provides simple visualization and data export of weather and climatological data archived at NCDC. The Toolkit also provides access to weather/climate Web services provided from NCDC and other organizations. The Viewer provides tools for displaying custom data overlays, Web Map Services, animations, and basic filters. The export of images and movies is provided in multiple formats. In 2009, several updates were made to support new Radar formats and data types including Super-Resolution NEXRAD and the Terminal Doppler Weather Radar network products. For more information, please visit www.ncdc.noaa.gov/oa/wct.

Next Generation Radar Dual Polarization Data in Real Time

In 2009, NCDC began receiving Dual Polarization (DP) radar data from the Norman, Oklahoma, experimental radar site in real time. NCDC is working with the Radar Operations Center to archive DP data for all 158 Next Generation Radar (NEXRAD) sites. Plans are for the NWS to transfer to the DP technology starting in 2010 and finish implementation by 2012.

Most weather radars transmit and receive radio waves with a single, horizontal polarization. DP radars transmit and receive both horizontal *and* vertical polarizations. Benefits from DP technology include improved hail detection for severe thunderstorm warnings, improved rainfall estimation for flood and flash flood warnings, rain/snow discrimination for winter weather warnings and advisories, data retrieval from areas of partial beam blockage to improve services in mountainous terrain, and removal of non-weather artifacts such as birds and ground clutter to improve overall data quality for algorithms and numerical model input.

Billion Dollar U.S. Weather Disasters Report Updated through 2009

The Billion Dollar U.S. Weather Disasters Report was updated to include 2009 events. Six events occurred with total losses exceeding \$10 billion. This is much lower than for 2008, when nine events resulted in over \$50 billion in costs. The decrease in 2009 was partly due to the very quiet 2009 Atlantic hurricane season. To access this information, along with previous years, please visit: www.ncdc.noaa.gov/oa/reports/billionz.html.

OBSERVING AND MONITORING SYSTEMS

The U.S. Climate Reference Network

The new U.S. Climate Reference Network (USCRN) project in Alaska commenced in 2009 with the installation of stations at the U.S. Geological Survey Shumagin Magnetic Observatory at Sand Point and near the Lake Clark National Park headquarters at Port Alsworth. These are the first of 29 new USCRN stations to be installed in Alaska over the next six years. Site surveys were completed and five sites were selected in December 2009 for future installations.

Another major project for 2009 was to install sets of soil moisture/soil temperature probes at USCRN stations in the continental United States. By the end of the year, 40 sets of probes had been installed with a standard installation consisting of 15 probes installed at three locations around a station at five levels: 5, 10, 20, 50, and 100 centimeters. Quality controlled observations were available online at www.drought.gov by mid-December 2009.

The base USCRN program continued to produce high quality data that were used to verify the reliability of current U.S. temperature time series in modern times. A major website revision occurred in mid-September 2009 that allowed observations and graphs related to both USCRN and the new U.S. Historical Climatology Network – Modernization (USHCN-M) Project to be accessed more readily. Please visit: www.ncdc.noaa.gov/crn/.

Several state climatologists (SCs) received funding from the State Climatologist Exchange Program to analyze climate data from USCRN stations. The SCs of Illinois and Utah performed major projects to produce climate summaries of USCRN stations. In addition, two small grants were received to perform cross-network comparisons of observations in a specific region and to determine optimal ways to distribute a

regional resolution station network in the mountainous West. The NOAA Regional Climate Centers were also proactive in providing access to USCRN data through their delivery systems, and the USCRN program worked to meet the data needs of a varied user community.

U.S. Historical Climatology Network Version 2 Release

Release of the U.S. Historical Climatology Network (USHCN) Version 2 dataset was accompanied by the publication of a *Bulletin of the American Meteorological Society* article describing the dataset and new bias adjustments that reduce uncertainty in temperature trends for the United States. The dataset of 1,218 U.S. Cooperative Observer Network stations is the most recognized source for the study of climate change in the United States. It is this dataset from which conclusions have been reached regarding trends and variability in U.S. surface temperature as part of the recently released U.S. Global Change Research Program report *Global Climate Change Impacts in the United States*. This dataset is also used by NOAA for monitoring the state of the climate in the United States on an operational basis and by the Intergovernmental Panel on Climate Change for the analysis of observed changes in climate.

The USHCN Version 2 dataset includes the use of groundbreaking solutions that made it possible to identify inhomogeneities in the U.S. temperature record even in the absence of station history information. Through development and application of the Pairwise Homogeneity Algorithm, hundreds of previously undetected discontinuities were removed from the U.S. temperature

record, greatly enhancing efforts to distinguish true changes in U.S. temperature from changes due to artificial factors. This dataset development effort was the first in the world to employ a fully automated method to identify and remove inhomogeneities, and it has established a standard which other countries are using to advance their efforts to develop homogenous datasets. For further information, please visit: www.ncdc.noaa.gov/oa/climate/research/ushcn.

Past Millennium Temperature Reconstruction

Methods developed by NCDC for state-of-the-art paleoclimate reconstructions were published in the January 2009 issue of *The Holocene*, titled “High-resolution Paleoclimatology of the Last Millennium.” These protocols are a fundamental step forward in the development of systematic testing procedures for annual to subannual climate reconstructions over the past 1,000 years, which represent the best effort in integrating paleoclimate information with instrumental data records, including those at NCDC.

Statewide Extremes Database Assessment

NCDC completed a state-by-state and element-by-element assessment of its statewide climate extremes database. In the process of examining each state’s maximum and minimum temperatures, 24-hour precipitation, 24-hour snowfall, and snow depth, “new” records were discovered or rescued, and existing records were corrected, invalidated, or otherwise changed. The new database now includes records for Puerto Rico and the U.S. Virgin Islands. They were provided to

Nineteenth Century Violin Paleoclimatology

Tree ring data from NOAA’s NCDC, usually used to evaluate past natural climate variations, were recently used to establish the calendar age of several nineteenth century violins. The resulting ring width series from these classic instruments were archived at NCDC for potential future archaeological purposes.



The Giant sequoia (*Sequoiadendron giganteum*) is the largest tree species on earth. Tree rings record the fluctuation of environmental factors that influence tree growth during the life of the tree. In many cases, trees grow to be hundreds or even thousands of years old and thus are an important source of information about environmental change.



NCDC's climate services partners (the National Climate Data Stewardship Team, Regional Climate Centers, and State Climate Offices) for review and approval. The new tables will be "living records" that will be informed by newly-arriving data and that can provide new benchmarks for quality assurance/quality control processes.

PARTNERSHIPS AND COLLABORATIONS

NOAA Collaboration with the American Association of State Climatologists

NCDC, NOAA's NWS, and other federal partners continue to engage members of the American Association of State Climatologists (AASC). In support of NCDC's three-tiered climate services vision (service at national, regional, and state levels), AASC individual State Climate Offices (SCOs) have been contributing climate monitoring and impacts reports to the Regional Climate Centers for inclusion in NOAA's *State of the Climate Reports*. SCOs have also presented over 1,000 lectures in the past year on various aspects of applied climatology reaching a broad audience that includes emergency managers, local elected officials, regional planning agencies, and teacher associations. SCOs provide critical client services to county-level Cooperative Extension Services, electric and water utilities, Drought Response Advisory Councils, as well as private businesses in many sectors. In addition, SCOs provide broad support for public outreach and educational programs and assistance for students enrolled in academic programs affiliated with SCOs.

At the 34th Annual Meeting of the AASC held in July 2009 it was reported that, as a result of a larger State Climatologist

Exchange Program grant from NCDC, 39 grants were awarded to 27 states. The bulk of the funds were used for three research areas: Monthly State Climate Impacts, U.S. Climate Reference Network and Historical Climatology Network – Modernization data summaries and applications, and the state climatologist climate economics survey to supplement the NOAA Economics web page.

NOAA's Regional Climate Centers

NOAA's Regional Climate Centers (RCCs) Program is a federal-state cooperative effort managed by NCDC. The six centers include:

- **Northeast Regional Climate Center** at Cornell University in Ithaca, New York
- **Southeast Regional Climate Center** at the University of North Carolina in Chapel Hill
- **Midwestern Regional Climate Center** at the Illinois State Water Survey in Champaign
- **Southern Regional Climate Center** at Louisiana State University in Baton Rouge
- **High Plains Regional Climate Center** at the University of Nebraska in Lincoln
- **Western Regional Climate Center** at the Desert Research Institute in Reno, Nevada

The RCCs help build the nation's climate archive and provide access to essential climate variables through the Applied Climate Information System, which was developed by the Northeast Regional Climate Center and is designed to manage the complex flow of information from climate data collectors to end users. Additional information concerning the RCCs role in a national climate service is provided at: www.ncdc.noaa.gov/oa/climate/RCCroleNationalClimateServicesFeb08.pdf.



State Climatologists and Regional Climate Center directors gather at the 34th Annual Meeting of the American Association of State Climatologists (AASC).

A recent example of the coordination between NCDC, the RCCs, and other parts of NOAA is the development of the U.S. Climate Reference Network and Historical Climatology Network –Modernization (USHCN-M) Program. The original Historical Climatology Network was identified in response to the need for the most accurate, unbiased, modern historical climate record available for detecting climate change in the United States over the past 100 years or more. Beginning with a pilot project in the Southwest, USHCN-M stations will be deployed at a 100 kilometer spatial resolution to provide for the detection of regional climate change signals. During 2009, the Western Regional Climate Center was very active in the placement of stations in this pilot project.

OUTREACH AND EDUCATION

NCDC User Engagement

In response to growing demand for comprehensive environmental data and information by specific socioeconomic sectors, NCDC has developed a sectoral program emphasizing twelve areas: *Agriculture, Civil Infrastructure, Coastal Hazards, Energy, Health, Insurance, Litigation, Marine and Coastal Ecosystems, National Security, Tourism, Transportation, and Water Resources.*

One way that NCDC engages its users is by sponsoring or co-sponsoring user workshops. These workshops serve as an opportunity for climatologists and climate-sensitive users to meet and discuss the types of climate data and information that are needed and available, as well as to identify any information gaps that may exist. There were several user workshops co-sponsored by NCDC in 2009; two are described below.

During September, NOAA and the International Trade Administration (ITA) held two one-day workshops entitled *Water and Energy Conservation: U.S. Department of Commerce Services for Agribusiness* in California. The workshops included panel discussions on NOAA climate services and ITA services for the agribusiness community. Business customers also shared the importance and usefulness of NOAA and ITA data and services. About 120 people attended the workshops including pump and irrigation equipment manufacturers, alternative energy companies, food processors, water and irrigation district managers, and economic development organizations.

Also during September, approximately 25 invited guests from the climate and health community attended the *Climate Change and Human Health: Assessing the Climate Information Gap* workshop at NCDC. Sponsors of the workshop included the Southeast Regional Climate Center, the Centers for Disease Control and Prevention, the U.S. Environmental Protection Agency, and the National Institute of Environmental Health Sciences. Those in attendance also included representatives from the U.S. Department of Agriculture, the Association of State and Territorial Health Officials, the U.S. Global Change Research Program, several medical schools, and various NOAA agencies. Discussions covered a wide range of climate-sensitive vector, water, and air borne diseases.

As a complementary form of outreach, User Engagement Fact Sheets have been developed for each sector. These fact sheets provide an overview of the sector, key stakeholders, examples of sector needs, and NCDC data and products of

particular interest to the sector. The fact sheets can be found on NCDC's user engagement website at: www.ncdc.noaa.gov/oa/userengagement/userengagement.html.

The Climate Literacy, Education, and Research Grant

NCDC is already a key partner of the National Environmental Modeling and Analysis Center at UNC Asheville, which applies knowledge from complex environmental datasets to the study of human-environment interactions. New funding—the Climate Literacy, Education, and Research Grant—enables that partnership and their collaborative discoveries to grow. This grant between UNC Asheville and NCDC focuses on education, research, and public outreach to increase understanding of local and regional climate systems, link sectoral engagement efforts with climate products, develop tools such as data visualization to address climate literacy, and ensure satisfactory accessibility of climate information to the public.

Student Internships

This was the eighth year of NCDC's Internship Program which provides opportunities for participants from a variety of programs. Students from across the nation participated in the program, learning in a real work environment and gaining hands-on experience in their particular area of interest. Each student prepared and presented a talk about their experience. The 14 interns, school affiliation, and principal project worked on at NCDC are listed below:

Cheickna Baber: North Carolina A & T, National Operational Model Archive and Distribution System and drought

Philip Bergmaier: Millersville University, Remote Sensing & Applications Division

Wilson Jones: North Carolina A & T, National Operational Model Archive and Distribution System: African wave development

Maggie Kovach: Climate and Health

Ryan Mayette: UNC Asheville, Economics

Nate Mullins: UNC Asheville, Global Observing System Information Center

Aaron Peet: Warren Wilson College, Temperature and Precipitation extremes

James Rogers: University of Georgia,
Climate Data Modernization Program

Kyle Sadelson: North Buncombe High School,
DATZILLA

Clay Tabor: UNC Asheville, Snow climatology

Jon Wheeler: University of Illinois at Urbana-
Champaign, NOAA Heritage Assets
bibliography research

Anna Wilson: UNC Asheville, Regional
snowfall indices

William Wright: North Carolina A & T,
Web services

Kelsey Watkins (Hollings Scholar): University of
North Dakota, Abrupt Climate Change as
observed in Paleoclimatology Records

with Weather/Climatology, Radar, Satellites, the TouchTable, and dendrochronology (tree ring dating). CLIMBE is funded by a grant from Burroughs-Wellcome.



Tami Houston uses the Magic Planet during a Bring a Child to Work event.

Bring a Child to Work Day 2009

NCDC's Bring a Child to Work Day, held on April 30, was a tremendous success with 31 students in attendance ranging in age from 5 to 17. The students were treated to a series of talks ranging from weather and climate to Doppler Radar to satellites to plant care. Attendees were fascinated by the Magic Planet and TouchTable demonstrations. Friendly rivalry was spurred on by a game of Weather Jeopardy. The building tour, held in previous years, was replaced with a personalized card making segment. Additionally, each child took home a bag of bean seeds to learn about germination and Dixie cups filled with potting soil and flower seeds, along with a large cypress tree sapling.



Greg Hammer shows a topographic map of western North Carolina to participants of a CLIMBE camp.



NOAA'S NCDC EMPLOYEES



Anders, Dee Dee



Anderson, David M.



Anderson, Gloria E.



Angel, William E.



Ansari, Steve



Applequist, Scott



Arguez, Anthony



Arndt, Derek



Arnfield, Jeffrey



Baker, Bruce*



Baldwin, Rich



Banzon, Viva



Bates, John J.



Bauer, Bruce A.



Bowman, David P.



Braun, Debra S.



Brewer, Michael J.



Brinegar, Danny



Briscoe, Robert



Brown, William



Buckner, Rodney



Burlew, Theodore T.



Burress, Robin



Burris, Mary R.



Burroughs, Jon



Capps-Hill, Sharon



Carpenter, Jan



Carr, Larry



Carr, Lila P.



Carter, Preston



Cholid, Luke



Coleman, Ken



Coren, Theresa D.



Crouch, Jake



Dahlberg, Harry W.



Davis, John W.



Del Greco, Stephen A.



Diamond, Howard



Dunston, Duane



Durre, Imke



Easterling, David



Esham, Terri



Evans, Robin



Faas, Wayne*



Fauerbach, John



Fincher, Katherine



Fleming, Steve



Franklin, Deb



Franks, Phala L.



Frederick, Helen



Gleason, Byron



Gleason, Karin L.



Goss, Andy



Graumann, Axel



Gross, Wendy



Grunin, Jason



Hall, Alan



Hammer, Gregory R.



Hastings, David



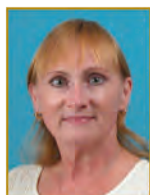
Hausman, Scott



Heim, Richard



Hensley, Grace



Herndon, Rhonda



Hinson, Stuart



Houston, Tamara



Hudspeth, Paul E.



Hughes, Pamela Y.



Hyatt, Glenn



Jensen, John A.



Karl, Cynthia B.



Karl, Thomas R.



Kearns, Ed



Kim, Dongsoo



Klein, Jody



Knapp, Ken



Kobar, John



Kossin, James



Kraft, Joseph E.



Lackey, Mark



Lasher, Blake L.



Lawrimore, Jay



Leary, Timothy



LeDuc, Sharon



Lefler, Donna F.



Levinson, David



Lief, Christina



Lott, Neal



Love-Brotak, Liz



Manns, Daniel J.



Markel, Anne



Martin, James M.



Mathews, Karon



Matthews, Brandis



Maybin, Billie F.



McCown, Sam



McElreath, Doug



McGahee, Alvin L.



McGill, Jolene



McGuirk, Marjorie



Menne, Matthew



Miller, Karen L.



Morgan, Beverly



Nagan, Robert A.



Nave, Sherri



Nelson, Brian



Nelson, Ryan



Nicodemus, Larry*



Owen, Karen



Owen, Timothy



Palecki, Michael



Payne, Ernest



Peterson, Thomas C.



Phillips, Angela



Pittman, Karol



Pressley, Jenny



Privette, Jeff



Ray, Henry*



Ray, Ronald



Riddle, Deborah B.



Ritchey, Nancy



Robel, Jeff



Ross, Douglas P.



Ross, Tom



Rutledge, Glenn



Sanchez-Lugo, Ahira



Schmidt, Ken



Scott, Tammy



Seiderman, Mark



Semunegus, Hilawe



Shaffer, Joyce



Shea, Eileen



Shein, Karsten



Shi, Lei



Smith, Adam



Smith, David P.



Smith, Elizabeth D.



Smith, Mark



Smith, Richard A.



Squires, Mike



Statler, Linda S.



Stephens, Scott



Steurer, Peter M.



Summers, Robert



Surrett, Nikonda



Symonds, Jason



Tarver, Kendra



Tessier, Margaret K.



Thomas, Adrienne



Thomas, John L.



Thomason, Charles W.



Turley, Kim*



Urbanski, David



Urzen, Michael



Veasey, Sara



Vose, Russell



Wahl, Eugene R.



Wall, Janet



Warnick, Barbara



Whitehurst, Tom



Williams, Claude N.



Wilmesherr, Mark



Woldu, Vernell M.



Womack, Winnie



Wright, Vickie S.



Wuertz, David



Young, Alisa



Zhang, Huai-min



Zhao, Xuepeng

NOTE: NOAA NCDC Employees indicated with an (*) either retired, resigned or transferred during the 2009 calendar year.

In 2009 awards were presented to NCDC employees for various achievements

- Thomas Karl: 2009 Presidential Rank Award
- Michael J. Brewer, Jon Burroughs, Wendy S. Gross, Richard R. Heim, Jr., Jay Lawrimore, Timothy W. Owen, Jason Symonds: NOAA Bronze Medal, for advancing the nation's ability to recognize, mitigate, and adapt to drought through the development of the United States Drought Portal.
- Huai-Min Zhang and Richard W. Reynolds: NOAA Bronze Medal, for developing the successful research-to-operation transition of Climate Sea Surface Temperature Observing System Design, Implementation and Performance Monitoring.
- John Bates: Category Winner, The Asheville-area 2009 Excellence in Public Service Award for Outstanding Heroic Act
- Jolene McGill: Category Winner, The Asheville-area 2009 Excellence in Public Service Award for Outstanding Administrative Professional
- Robert Nagan: Federal Sector Nominee, The Hoyt Abney Outstanding Community Service Award
- Ahira Sanchez-Lugo: Federal Sector Nominee, The Asheville-area 2009 Excellence in Public Service Award for Outstanding Contribution to Improving Diversity

NCDC CONTRACT EMPLOYEES



Alleman, Jeff



Anderson, Heather



Annis, Arthur



Anthony, Steven



Ball, Erin



Beitler, Brian



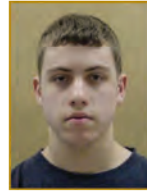
Bilotta, Rocky



Blunden, Jessica



Bober, Philip



Brannock, Jonathan



Brown, Otis



Buddenberg, Andrew



Byrd, Thomas



Calkins, John



Chapal, Scott



Cooper, Jason



Crandall, Lea



Davis, Jesse



Dellinger, Dan



Dockery, Jason



Dunbar, Dianna



Duncan, Mike



Embler, Scott



Enloe, Jesse



Evans, Steve



Fenimore, Chris



Fey, Andrea



Fisher, Ed



Fotos, Arthur



Freeman, Eric



Gardiner, Ned



Gibney, Ethan



Gille, Edward P.



Godfrey, Elaine



Goodge, Grant



Griffin, Reggie



Grinestaff, Jeff



Groisman, Pasha



Hankins, Bill



Harraman, Paige



Hartman, Michael



Hennon, Paula



Hicks, Josh



Houston, Scott



Jenkins, Michelle



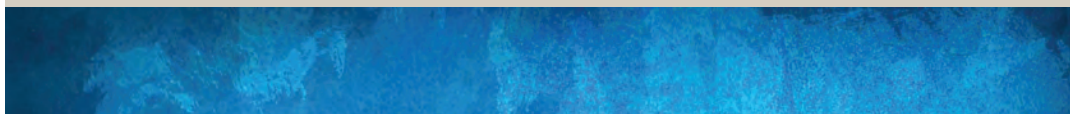
Jones, Peter



Jones, Philip



Kantor, Diana



Kari, Uday



Klausmann, Leo



Korzeniewski, Bryant



Krolak, Lisa



Kruk, Michael



Liu, Chunying



Markham, David



Marra, John



May, Brian



McElreath, John



McFadden, Robert



McNeill, Shelley



McPherson, Terry



Means, Tiffany



Misch, Deb



Moore, Julie



Morley, Bentley



Morrill, Carrie



Murray, William



Nakagawa, Lynn



Ngo, Michelle



OConnell, Dianna



Osborne, Susan



Patten, Rob



Peng, Ge



Petrasek, Vincent



Phillips, Mark



Polprasert, Pichai



Pritchitt, James



Reid, Glen



Reynolds, Richard W.



Roberts, Charlie



Roberts, Ken



Ross, Daniel



Ross, Leejah



Rouse, Kelvin



Rowan, Nancy



Saunders, Drew



Schultz, Keith



Shah, Anju



Sharp, Jason



Shepherd, Ethan



Slagle, Mary



Smith, Fred



Smith, Sharon



Snipes, Gaysha



Sprain, Mara



Stanton, Vincent



Stroumentova, Nina



Swank, Dan



Tate, Charlette



Teal, Tom



Thomas, Devin



Thomas, Kristy



Toner, Valerie



Torres, Bernardo



Truesdell, Rod



Urzen, Jennifer



Vasquez, Lou



Wagner, Amy



Wallis, Trevor



Waple, Anne



Wilkinson, Jon



Wise, Shane



Wilson, Anna



Wong, Eric



Wunder, Daniel



Yin, Xungang



Young, Teresa



Zamarra, Christian

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